



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

BULLETIN
OF THE
TORREY BOTANICAL CLUB

JULY, 1904

Chemical notes on "bastard" logwood *

BENJAMIN C. GRUENBERG AND WILLIAM J. GIES

During the past few years the growers of logwood in Jamaica have been greatly disturbed by an apparent increase on their properties of an unmerchantable variety of the plant known as "bastard" logwood.† The exportation of this wood along with real logwood has served to condemn all the logwood from the districts which have shipped it.‡

"Bastard" logwood differs from the genuine varieties, from the dyer's standpoint, in yielding little or no hematoxylin, but, instead, a yellowish-green pigment which is of no value and which, when admixed with the commercial extract, reduces the characteristic tinctorial properties of the latter. Chips of the "bastard" logwood present a yellow, pale pink, white or even chocolate-colored surface instead of the dark red or deep purple, bronzed-tinted color of the best Jamaican or Mexican logwoods of commerce. There appears to be considerable uncertainty, even when the trees are cut down, as to whether a tree is really a "mulatto" ("bastard") tree or not. What is known as a "mulatto" tree is frequently dark enough when first cut to lead one to believe that it is a good redwood tree, but instead of darkening with age as all the good wood does, it remains the same color or becomes lighter rather than darker. The "bastard" tree

* From the New York Botanical Garden, New York. Some of the chemical work was done in the laboratory of physiological chemistry of Columbia University.

† Fawcett: Bulletin of the Botanical Department, Jamaica, 3: 179. 1896.

‡ Clipping from a Kingston, Jamaica, newspaper, sent to Dr. D. T. MacDougal by Hon. William Fawcett (September, 1901).

[The preceding number of the BULLETIN, Vol. 31, No. 6, for June, 1904 (31: 309-366, *pl.* 13, 14) was issued 24 June, 1904.]

seems to be perfectly dry, and even when the chips are soaked for a long time in water, they give out no dye.*

Various theories have been advanced to explain the apparent increase in the "bastard" logwood in Jamaica. Professor F. S. Earle, after a thorough study of the situation in Jamaica, came to the following conclusions: †

1. "Logwood is a variable plant showing marked differences in form, color and texture of leaf; time of blooming; form and extent of ribs on the trunk; color of bark and especially in the color and dye-producing quality of the heart-wood. Four well-marked varieties are said to be recognized in Honduras and three are usually recognized in Jamaica, but there are many other intermediate forms."

2. "Bastard" wood is not the result of disease or of any lack of vigor. The trees producing it are perfectly healthy and normal.

3. "It is not the result of soil or climatic conditions, since 'bastard' and normal trees are found growing side by side under absolutely identical conditions."

4. "It is not the result of immaturity. Aged trees may produce 'bastard' wood, while in normal trees the heart-wood, as soon as formed, contains a good percentage of hematoxylin. These facts seem to point to heredity as the probable cause of the trouble. That is, that certain trees produce only 'bastard' wood because they grow from the seed of a 'bastard' tree; or in other words that 'bastard' logwood represents a variety of *Haematoxylon campechianum* that normally produces little or no hematoxylin, just as one Honduras variety has smaller, shorter, thinner and lighter colored leaves."

Some time before Professor Earle made his investigations in Jamaica we began, at Dr. MacDougal's suggestion, a comparative study of logwoods from that island, in the hope of finding definite chemical differences, other than purely tinctorial ones, between "red logwood" and the "bastard" variety. Unfortunately our work in collaboration was soon unavoidably interrupted. We present here very briefly, however, such of our notes in this connection as may be of general interest.

*Cradwick: Report to the Chairman of the Experiment Station, Kingston, Jamaica, 1902 (April 4).

† Earle: Journal of the New York Botanical Garden, 4: 3. 1903.

ELEMENTARY COMPOSITION OF HEART-WOOD. — Elementary analysis of typical samples of (1) the red logwood of commerce, (2) a "bastard" variety somewhat resembling it and (3) a second specimen of the "bastard" type yielding hardly any pigment to water gave the following results:

TABLE I.

PERCENTAGE ELEMENTARY COMPOSITION OF SUBSTANCE DRIED TO CONSTANT WEIGHT AT 110°C.*

	I.			II.			III.		
	"Red" Logwood.			"Bastard" (medium grade).			"Bastard" (poorest quality).		
	C†	H	Ash.	C†	H	Ash.	C†	H	Ash.
1	51.91	5.98	1.80	51.45	5.83	1.59	51.04	5.67	2.03
2	52.00	5.80	2.06	51.77	6.03	1.68	51.35	5.74	1.86
3	52.12	5.76	1.71	51.45	6.03	—	51.00	5.58	—
Av.	52.01	5.84	1.86	51.56	5.96	1.63	51.13	5.66	1.94

SUMMARY OF AVERAGES.

	I.	II.	III.	General Average.
Carbon,	52.01	51.56	51.13	51.57
Hydrogen,	5.84	5.96	5.66	5.82
Ash,	1.86	1.63	1.94	1.81
Oxygen.‡	42.15	42.48	43.21	42.61

The most significant feature of these results is the decreasing amount of carbon in the "bastard" wood. The differences are too slight to warrant any emphasis, but are such as might be due to a lower percentage of hematoxylin, which is a pigment of high carbon (and low oxygen) content — $C_{16}H_{14}O_6$.

The data of the second series of analyses, given in TABLE II, show that the wood was not decomposed in the process of drying to constant weight at 110° C. (first series) and that, therefore, the previous results were not influenced by that procedure.

GENERAL COMPOSITION OF SEEDLINGS. — In TABLE III we present the results of some analyses of seedlings of "red" logwood

* Only heart-wood was employed in this work. This was converted into sawdust and only such portions as passed through a very fine sieve were taken for analysis. The methods of analysis were those which are now in general use.

† The figures for carbon and hydrogen are calculated (from the data of direct analysis), for *ash-free* substance.

‡ Calculated, by difference, for *ash-free* substance.

TABLE II.

PERCENTAGE ELEMENTARY COMPOSITION OF SUBSTANCE DRIED TO CONSTANT WEIGHT AT 20 C.^o

	I.			II.		
	C	H	H ₂ O	C	H	H ₂ O
1	46.90	5.40	7.95	46.58	5.28	7.97
2	46.98	5.24	—	46.87	5.45	—
3	47.08	5.20	—	46.58	5.45	—
Average.	46.99	5.28	7.95	46.68	5.39	7.97

and of the "bastard" variety. The condition of the seedlings at the time of analysis is shown in FIGURE 1. The outward appearance of the two kinds of seedlings was practically the same. Likewise, the differences among the figures in our table for general chemical composition are too slight to warrant any other conclusion than that the seedling metabolism was, in general, essentially the same in both varieties. The analyses were made 12 months after seeds were planted.

TABLE III.

GENERAL COMPOSITION OF LOGWOOD SEEDLINGS.*

		Water.		Solids.					
		Red.	Bastard.	Total.		Organic.		Inorganic	
				Red.	Bastard.	Red.	Bastard.	Red.	Bastard.
Leaves,	<i>a</i>	60.33	60.05	39.67	39.95	37.08	36.93	2.59	3.02
	<i>b</i>	59.89	—	40.11	—	37.70	—	2.41	—
	<i>c</i>	56.27	51.22	43.73	48.78	41.08	45.94	2.65	2.84
Upper stem,	<i>a</i>	63.57	60.68	36.43	39.32	34.72	36.50	1.71	2.82
	<i>b</i>	43.77	38.34	56.23	61.66	54.40	58.29	1.83	3.37
	<i>c</i>	39.06	34.01	60.94	65.99	59.08	63.99	1.86	2.00
Lower stem,	<i>a</i>	43.68	45.89	56.32	54.11	54.61	52.50	1.71	1.61
	<i>b</i>	43.19	39.99	56.81	60.01	55.62	58.32	1.19	1.69
	<i>c</i>	36.83	32.97	63.17	67.03	61.63	65.24	1.54	1.79
Roots,	<i>a</i>	43.39	44.46	56.61	55.54	55.41	54.14	1.20	1.40
	<i>b</i>	67.93	61.66	32.07	38.34	30.52	35.39	1.55	2.95
	<i>c</i>	65.32	70.58	34.68	29.42	33.20	27.70	1.48	1.72
		—	49.17	—	50.83	—	46.87	—	3.96

* Analyses were made by the usual drying and incineration methods. The portions subjected to comparative analysis were approximately of the same morphological location in each variety. The most significant differences seem to be the slightly larger proportion of water in the "red" wood and the relatively greater quantity of solids, especially inorganic matter, in the "bastard" samples.

CONCLUSIONS FROM THE GENERAL ANALYTIC DATA. — All of the preceding analytic results make it evident that the chemical differences existing among these logwoods are quantitatively very slight. They also make it appear probable that the variations in the different samples of the wood are chiefly variations in the chemical

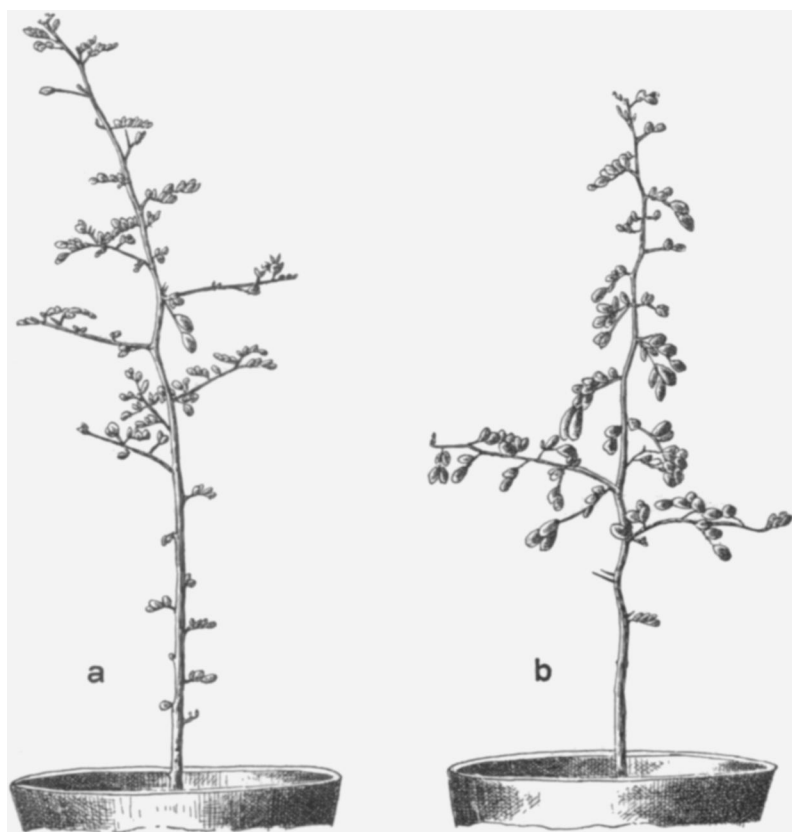


FIGURE 1. Seedlings of logwood, one year old. a, "red logwood." b, "bastard logwood." Both grown from seeds obtained from "Old Hope" plantation, Jamaica.

characteristics of the pigments themselves, which, as is well known, possess as a rule high tinctorial qualities even when they occur in only very small amounts. Our results in this connection would also indicate that there are no striking structural differences among these varieties of logwood. They suggest, likewise, that even

metabolic tendencies in these logwoods are essentially the same, varying only, perhaps, in the course of events which involve relatively slight quantities of pigment.*

TINCTORIAL DIFFERENCES. — The foregoing results having shown that the differences among these logwoods were chiefly if not solely tinctorial, we next endeavored to ascertain the extent of the pigmentary variations.

Our first experiments in this connection were efforts to determine the relative tinctorial intensity of extracts of different samples of heart-wood sawdust made with equal volumes of various solvents under similar conditions of temperature, shaking, etc., from the same quantities of material dried to constant weight at 110° C.† Among the samples were several inferior qualities of red wood from dead and decaying trees.

TABLE IV gives our first results in this connection. The figures in that table denote the relative positions in a series of ten extracts — 1 indicating weakest coloration, 2 the pigmentation of next higher intensity and so on to 10 showing the most decided tinctorial effect.

The shade of color varied with each extractant, as would be expected. The following observations were made in this connection, on the color of the series of extracts referred to in TABLE IV.

- I. Water—slight yellowish-brown to deep reddish-brown.‡
- II. 0.2 per cent. HCl—faint yellow to orange.
- III. 2.0 per cent. HCl—faint yellow through reddish-brown to bright red.
- IV. 0.01 per cent. KOH — chocolate coloration throughout.
- V. 0.15 per cent. KOH — deep chocolate coloration throughout.
- VI. 0.5 per cent. Na_2CO_3 — chocolate coloration throughout; less than in V, greater than in IV.
- VII. Saturated borax solution — faint yellow to deep reddish-yellow.
- VIII. Ether — faint yellow to orange.
- IX. Absolute alcohol — faint yellow to red.
- X. Acetone — faint yellow through greenish-yellow to yellowish-red.
- XI. Acetic ether — faint yellow to deep reddish-yellow; brighter than in VII.

* These conclusions are in harmony with those drawn from other standpoints by Professor Earle (quoted on page 368). They were arrived at independently by us and were included in our report, in December, 1902, to the Botanical Society of America, before we were aware of Professor Earle's deductions. *Science*, II. 17: 338. 1903.

† Drying occurred rapidly and seemed to have no transforming effect on the dust. This fact was noted before in another connection (page 369).

‡ The coloration intensities are indicated progressively from 1 to 10 (see TABLE IV). Individual exceptions are not referred to.

XII. Chloroform — no color in some, faint yellow in others.

XIII. Benzol — no color in any.

TABLE IV.

RELATIVE PIGMENTATION OF VARIOUS KINDS OF LOGWOOD.

Extractant.	A	B	C	D*	E	F	G	H	I	J
I. Water.	1	2	3	10	4	6	7	5	8	9
II. 0.2 % HCl.	1	2	5	7	6	3	4	10	9	8
III. 2.0 % HCl.	1	2	4	3	5	6	7	8	9	10
IV. 0.01 % KOH.	1	2	4	3	5	6	7	8	9	10
V. 0.15 % KOH.	2	4	1	3	5	7	6	8	9	10
VI. 0.5 % Na ₂ CO ₃ .	2	3	1	6	4	5	7	8	9	10
VIII. Ether.	1	2	5	4	8	7	9	6	3	10
IX. Absolute alcohol.	1	2	4	3	6	5	9	7	8	10
X. Acetone.	1	2	4	3	5	9	6	7	10	8
XI. Acetic ether.	1	2	3	4	6	7	5	9	8	10
Average.	1.2	2.3	3.4	4.6	5.4	6.1	6.7	7.6	8.2	9.5

A—"Bastard" (very poor). B—"Bastard" (very poor). C—Immature wood of varying tints. D—"Purple" (from tree on extremely poor marly bank; tree mature, but dead in nearly all parts, including the roots). E—Immature wood of varying tints. F—"Bastard" (medium grade). G—Red (tap root of nearly dead tree). H—Red (tree over ripe; wood bored by ants). I—Red (from roots of dead tree). J—Red (best grade).

More important, however, than the variations in the shades of color in the extracts was the fact, already noted, that the *sequence* of coloration intensity (in extracts made under like conditions in detail in each series) *varied* with each solvent (TABLE IV). This result not only shows that the colors of the woods are not due merely to different amounts of the same pigment but also proves that the pigmentary differences are caused either by varying proportions of at least two pigments, or by the same pigment radical in more than one chemical condition — in combinations, it may be of different solubilities and stoichiometric relationships, and of different dissociable tendencies.

Relative tinctorial differences and variations are further shown in the following sample data, which indicate the quantity of water in c.c. added to 10 c.c. of 0.5 % Na₂CO₃ extract (TABLE IV) in order to make the tinctorial intensity approximately the same throughout the series.†

* This sample contained several pigments. One of these was purplish and quite unlike any in the other samples. The pigment was especially soluble in water. It was not ordinary hematoxylin.

† Dilution of D with an equal volume of water furnished the basis of coloration for the comparative observations.

TABLE V.

Sample of Logwood.	Water Added.	Sample of Logwood.	Water Added.
A	3.5 c.c.	C	7.5 c.c.
B	3.5	D*	10.0
F	5.5	H	10.9
E	7.1	I	12.2
G	7.1	J	17.8

The letters correspond to those in TABLE IV.

The tinctorial sequence after the above dilution is different from what it was before dilution as may be seen from the following summary : †

TABLE VI.

	1	2	3	4	5	6	7	8	9	10
Before dilution (TABLE IV).	C	A	B	E	F	D	G	H	I	J
After dilution (TABLE V).	A	B	F	E	G	C	D	H	I	J

The above facts are in further harmony with the foregoing conclusions regarding cause of coloration effects and relative differences.

Dilute aqueous extracts of two samples of red logwood and of one medium grade "bastard" wood all showed a similar yellow color, by transmitted light. The shades of color did not differ noticeably except in degree. In stronger extracts of equal concentration the first two appeared more reddish.

Treatment with alkalies, volatile and non-volatile, turned the color of the red logwood extracts to a blood-red, passing into purple, whereas in the "bastard" extract the shade of yellow was merely deepened, passing into the dull brown color of faded oak leaves. Dilute and concentrated mineral acids turned the yellow of the dilute aqueous extracts of the red wood into a color ranging from orange to bright red. In the "bastard" extract no such change was perceptible.

These differences in the behavior of the two sets of aqueous extracts toward acids and alkalies correspond to the differences between the reactions exhibited toward the same reagents by a

*This color was of the same intensity as the rest, but not the same shade. See footnote, page 373.

† A similar change in sequence of tinctorial intensity after dilution was noted in other extracts, also.

freshly prepared solution of the commercial "extract of logwood," and a solution four weeks old that had faded to a straw-yellow.

The chemical alterations undergone by the aqueous solution of the commercial extract are accompanied by such a decided change in color and in chemical properties that from a comparative study of such extracts we expected to learn something definite regarding the actual differences between the pigments in the heart-wood of "red" logwood and in that of the bastard variety. We were unable, however, to do so.

Experiments were started to determine, if possible, the relations of light and of air to the discoloration of solutions of logwood extracts. In a few weeks all the preparations had been attacked by growths of *Penicillium*, *Rhizopus* and other fungi. After filtration the solutions showed no appreciable differences in shade or color. But on diluting these filtered solutions with two parts of water and eventually with eight parts, differences were readily observed.

The solutions which had been in the light showed no change in color, whereas those kept in the dark had become distinctly yellow. The extracts to which the air had free access manifested the greatest changes.

SOLID MATTER IN LOGWOOD EXTRACTS. — We desired to ascertain, in comparative determinations, the quantities of solid matter in aqueous extracts of the various logwoods under investigation. The absolute amount of solid substance in 100 c.c. of the extract was always small — less than 0.02 gram. In the drying process slight decomposition seemed to result and perfectly constant weights could be obtained only after a long time. Although the absolute changes in weight were only very small, the proportionate variations in quantities so slight were quite large. For these reasons no comparative observations were attempted in this connection. The use of very large volumes of extract, to reduce the comparative effects of the variations referred to, was impracticable.

The general question of the physiology or chemistry of pigment-formation in the heart-wood was not approached at all, nor were the histological characters of the varieties compared.

There can be no doubt that "bastard" logwood is, as Prof. Earle also concludes (see page 368) a distinct variety or subspecies

of *Haematoxylon campechianum*, notwithstanding the slight morphological differences that distinguish it from the "red logwood" and "blue logwood." The differences in the floral organs between

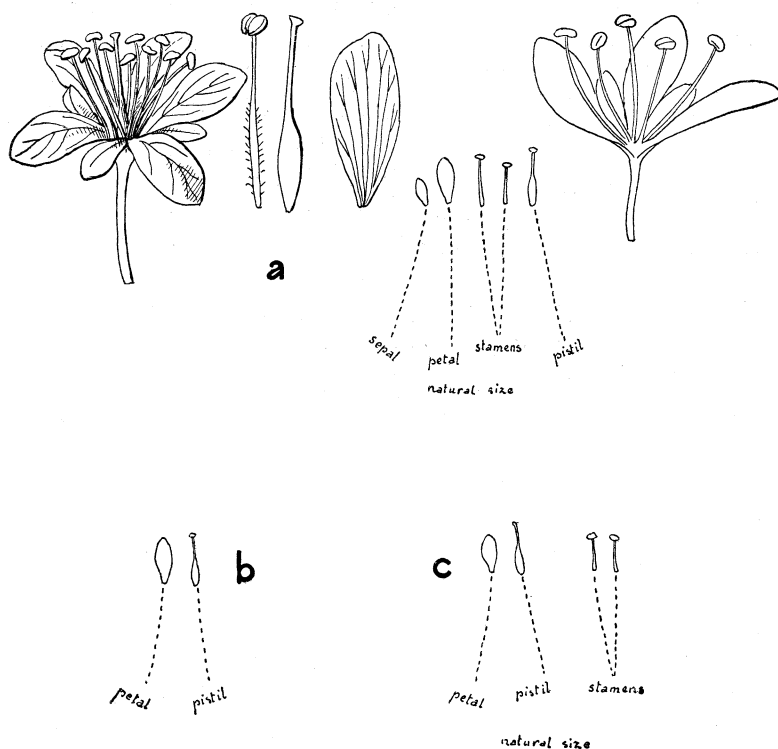


FIGURE 2. These drawings, which were made from specimens collected by Hon. William Fawcett near Morant Bay, Jamaica, show all the morphological differences that have been observed in the flowers of three varieties: *a*, "blue logwood," *b*, "red logwood," *c*, "bastard logwood."

The petals are widest in the blue and narrowest in the bastard.

The pistil of the blue is thicker than that in the red and the bastard. The style in the bastard is slightly curved.

In the bastard the stamens are smaller than in the others, and there is less difference between them.

It does not appear from the data at hand that the differences noted exceed the ordinary individual variations for the species of *Haematoxylon*.

the three varieties are shown in FIGURE 2, which was made from drawings sent by Mr. Fawcett, of the Jamaica Botanical Gardens.

That there are species which are not at all distinguishable from one another externally, but which vary in their physiological prop-

erties, is a recognized fact,* and the "bastard" logwood may simply be a new example of the same phenomenon. A parallel case would seem to be furnished by the black locust (*Robinia pseudacacia*), the wood of which is described by Sargent† as being "reddish, greenish-yellow or white, *according to locality*"; but the yellow and white varieties occur side by side in at least one locality.

SUMMARY.

1. The most significant fact shown by elementary analysis of the heartwood of typical specimens of logwood was the lower carbon content of the poorer wood, which may be due to lower pigment content, hematoxylin being a compound containing nearly twice as much carbon as oxygen.

2. No morphological differences are discernible between red logwood and bastard logwood in the young seedlings.

3. Analyses of the various seedlings agreed too closely to warrant any conclusion but that the metabolism of the seedlings was essentially alike in the two varieties.

4. The chemical differences between red logwood and "bastard" logwood are very slight, and are probably due to differences in amount of pigment.

5. Extractions with various solvents gave solutions of different colors, and also of varying orders of intensity in the several series, indicating the presence of at least two pigments in varying proportions, or a pigment radical in different combinations.

6. This was confirmed by the fact that the order of coloration intensity of a series of extracts was altered by diluting with water.

7. Aqueous extracts of the two varieties of logwood gave different reactions to acids, alkalies and other reagents. The differences are parallel to those between a fresh aqueous solution of commercial logwood "extract," and the same solution after it had become discolored on long standing.

8. Attempts to determine the conditions of the discolorations of solutions of commercial "extract," failed to yield definite results, but indicated, in general, that darkness and air are favorable to the change.

NEW YORK BOTANICAL GARDEN.

* DeVries : *Mutationstheorie*, 1 : 122. 1901.

† Sargent : *Catalogue of the forest trees of North America*, 15. Washington, 1880.